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REGION II TECHNICAL NOTES - NO. 1

SELECTION OF MAP BASE FOR SMALL SCALE ANALYSIS AND PREDICTION

by

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SELECTION OF MAP BASE FOR SMALL SCALE ANALYSIS AND PREDICTION

Most of the material contained in this Note has been taken from Air Weather Service Manual 105-35, "The Local-Area Surface Chart, Its Preparation and Use", Chapter 2. This Manual is not generally available at all Weather Bureau field stations, and some of the material in the Manual is not applicable to Weather Bureau operations; so this means of distributing those portions pertinent to the small scale analysis and prediction programs in Region II is being used.

To set up a small scale analysis program, a station should choose an appropriate map scale. The map scale of the base chart and the physical scale of the atmospheric systems to be analyzed are closely related, hence before considering several factors in selecting a map base a brief discussion of scales of atmospheric systems will be given.

Most weather phenomena are considered to have characteristic scales in both space and time. For instance, a complete description including both the analysis and prognosis of a squall line which will pass over a state in a few hours can be contained in a detailed analysis-prognosis of a small section of the United States. However, a description (analysis and prognosis) of a major winter cyclone off the Pacific Coast of North America, which may take several days to cross the United States, requires a much less detailed analysis over North America as well as the eastern section of the Pacific Ocean. The three prefixes: macro, meso, and micro which have come into use in recent years are sometimes used loosely and even interchangeably, so that their meanings are often misunderstood. A system of classification advocated by AWS which appears adequate for our purposes is presented in the attached table.

As can be seen from this table, the macro-, meso-, and microscales do not adequately define the entire spectrum of atmospheric systems. Two other scales, the small synoptic and local scales have been added to make the spectrum more complete.

Macroscale weather systems. These are the long waves or major surface cyclones or anticyclones and their frontal systems. They are usually greater than 250 miles in size and have a life-cycle of days, or even weeks. They are accompanied by widespread weather patterns which contain extensive areas of clouds and precipitation separated by areas of clear skies. The present hemispheric surface and upper-air network of stations, spaced from 150 to 300 miles apart (over the continents) is designed to observe macroweather systems. Thus, the analyses and prognoses which appear on the National Facsimile Network usually are made on the macroscale.

Mesoscale weather systems. These include surface-pressure troughs or ridges and temperature-chance patterns such as those which accompany a well-organized group of thunderstorms and showers in a squall line. These systems may vary from 10 to 100 miles in size and from one to several hours in duration. Special networks of surface-observation stations spaced 5 to 50 miles apart are needed to observe properly the mesoscale weather systems. Radar-echo patterns provide an excellent means of observing mesosystems. Much time and effort are presently required to plot meso-network data properly and analyze weather phenomena in the mesoscale. However, extensive research on weather systems of this scale has provided valuable descriptive material of the mesoscale phenomena which has never been adequately described in studies on macroscale weather systems. Indeed, the models derived from studies of mesoscale phenomena can be used as guides when making local-area analyses.

Microscale weather systems. These are very small weather systems which are characterized by dimensions of inches to thousands of feet, and seconds to a few minutes of time. Wind and temperature variations in the first few hundred feet above the earth's surface are examples of microscale systems.

Local-scale weather systems. Tepper (1) proposed that those systems visible to the eye from a single observation point be considered as Local-Scale systems, as these have a characteristic dimension of "less than five miles". (In the attached table, however, the upper-size range has been raised to 20 miles which is more appropriate for some of the meteorological examples used.)

Small-synoptic scale weather systems. This zone in the spectrum of weather-phenomena scales between the macro- and mesosystems is of particular interest to a local program of small scale analysis and prediction. Spar (2) has called this zone the "small-synoptic scale", and a paragraph from his discussion of this scale is quoted:

".....a considerable part of the forecaster's attention is also devoted to what may be termed the 'small synoptic scale' for which the characteristic distance in the United States is the separation between the hourly reporting airways weather stations and the characteristic time is one hour or less. When examined on this scale, the structures of fronts, the shape of the pressure field, and the distribution of rain and wind may bear little resemblance to models based on larger-scale analysis."

It is expected that most field stations will be working in the general area of the mesoscale, ranging up to the small-synoptic where data are relatively sparce, and down to the local-scale in a few areas where data are more plentiful or where there is a possibility of developing observations.

Before choosing a map base for a local or sectional analysis program several factors should be considered:

1. The directions from which weather systems approach the station. These directions will usually vary with the seasons. The best source for this type of information is Research Paper No. 40, U. S. Weather Bureau "Principal Tracks and Mean Frequencies of Cyclones and Anticyclones in the Northern Hemisphere". The plotting area should then be oriented to include the tracks affecting the station.

2. The maximum distances from all directions traveled by weather systems which cross the local area during a 12-24 hour interval. These distances will vary with the seasons. The winter travel figures will probably determine the required distance out from the station in each compass direction.

3. Topographic features which influence even the small-scale local weather. Rivers and lakes, hills and valleys, are the most common topographical features which influence the local weather.

4. A paper area for the local area chart large enough to allow space for the plotting of data at most of the observation stations on the chart. The plotting space available on a chart depends on the report density. For instance, over the Eastern United States observation stations are in some places spaced only 10 to 15 miles apart; however, over the Midwestern United States the average distance between stations is about 100 miles.

5. The optimum-sized paper for the local area chart which the human eye can scan in a single glance. At normal reading distances for weather maps, this is about five square feet.

6. The best map projection or manner in which the round earth is drawn on flat paper. Any of the conformal projections can be used, that is, the Lambert Conformal, Polar Stereographic, or Mercator projections. Scales of 1:1 million, 1:2 million and 1:3 million are available in the Lambert Conformal Projection with two standard latitudes; the Polar Stereographic Projection, and in lower latitudes the Mercator Conformal Projection, remain the standard for all weather plotting charts with scales 1:5 million or smaller.

Map scales between and including 1:3 million and 1:10 million will best satisfy the criteria listed above for proper choice of a map base. For scale ratios larger than 1:3 million, the distance between reporting stations is too great for a coherent analysis of the small-synoptic scale and are better suited to the local-scale, as defined above. Map-scale ratios smaller than 1:10 million, e.g., 1:15 or 1:20 million, are usually used for macro-scale hemispheric analyses prepared at NMC. In areas where reporting stations are frequently located closer together than 50 miles a 1:3 million or 1:5 million scale best satisfies the requirements considered above. Where observations average about 100 miles apart, a 1:5 or 1:7.5 million scale will best satisfy the requirements.

(1) Tepper, M.: "Mesometeorology - The Link Between the Macroscale Atmospheric Motions and Local Weather", Bull. Amer. Met. Soc, Vol 40, No 2, Feb 1959, pp 66-72.

(2) Spar, J.: "An Analysis of a Cyclone on a Small Synoptic Scale", Mon. Wea. Rev., Vol 84, No 8, August 1956, pp 291-300.

SCALE OF ATMOSPHERIC SYSTEMS

Synoptic Scale	Characteristic Dimensions	Meteorological Examples	Necessary Spacing of Observational Network
MACRO	250 Miles Several Days	Long Waves Cyclones Frontal Systems Widespread Precip. Area	150 to 300 Miles
SMALL SYNOPTIC OR SUB-SYNOPTIC	50 to 300 Miles Several Hours	Bubble-Highs Unsmoothed Isobaric and Frontal Patterns Hourly Changes (P, T, Precip.)	50 to 150 Miles
MESO	10 to 100 Miles Hours	Mesosystems (P, T, Precip.) Radar-Echo Patterns	5 to 50 miles
LOCAL	1 to 20 Miles Several Minutes to an Hour	Visible Weather Cloud Patterns Local Storms Tornado Systems	1000's of Feet to 5 Miles (Visible from a Single Station)
MICRO	Inches to 1000's of Feet Seconds to Minutes	Wind, P, T, or Precip. Variations (turbulence) up to a few Thousand Feet	Inches to 100's of Feet

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
Fort Worth, Texas

May 19, 1965

RO2/M

REGIONAL MEMORANDUM

TO : All First Order Stations in Region II

FROM : Fort Worth Regional Director

SUBJECT: Selection of Map Base for Small Scale Analysis and Prediction

REFERENCES: (1) Regional Memorandum dated April 14, 1965; Techniques Improvement for Small Scale Analysis and Short Period Forecasts.

(2) Attached Region II Technical Note No. 1

The attached Technical Note is being distributed as a possible aid in the selection of appropriate large scale plotting charts by those stations having requirements for such maps in their small-synoptic or sub-synoptic analysis programs. Your requirements for a base map best suited to your needs should be submitted to the Regional Office for validation and coordination in order that the requirements of several neighboring stations may be considered so that one chart may serve as many stations' needs as possible.

Also attached is a bibliography on small-scale analysis for use as background information.

W. L. Thompson

W. L. Thompson

Attachments

BIBLIOGRAPHY ON SMALL-SCALE ANALYSIS AND PREDICTION

1. "Mesometeorology--The Link Between the Macroscale Atmospheric Motions and Local Weather", M. Tepper, BAMS, February 1959.

2. "An Analysis of a Cyclone on a Small Synoptic Scale", Jerome Spar, MWR, August 1956.

3. "Mesoanalysis--An Important Scale in the Analysis of Weather Data", T. Fujita, H. Newstein, M. Tepper, USWB Research Paper No. 39, Washington, D. C., 1956.

4. "The Local Area Surface Chart--Its Preparation and Use", Air Weather Service Manual 105-35.

5. "On the Mesometeorological Field Studies Near Flagstaff, Arizona", T. Fujita, K. A. Styber, R. A. Brown, JAM, March 1962.

6. "Topometeorology--The Local Scale", M. J. Schroeder, BAMS, August 1961.

7. "Principles of Meteorological Analysis", W. J. Saucier, University of Chicago Press, 1955.

8. "A Series of Subsynoptic Scale Weather Systems of January 30, 1963 - A Case Study", OFDEV Technical Note No. 14, G. A. Petersen, D. M. Hanson, March 1964.

9. "Mesoscale Analysis of Existing Meteorological Network Data", Robert D. Elliot, etal. Final Report on Contract No. Cwb 10326 to the U. S. Weather Bureau, April 30, 1963. Aerometric Research, Inc.